

CLAIMS:

1. An angle detection apparatus that is inputted with
output signals from first and second magnetic sensor
5 units for detecting magnetic components in at least
two directions, and detects a relative angle with
respect to a magnetic field from said magnetic
components, said apparatus comprising:
control means for controlling an output signal in
10 a first direction component detected by said first
magnetic sensor unit so as to have a fixed value; and
driving means for driving said second magnetic
sensor unit to detect an output signal in a second
15 direction component according to the same drive
conditions as those at the time when said first
magnetic sensor unit is controlled by said control
means.
2. An angle detection apparatus that includes first
20 and second magnetic sensor units for detecting
magnetic components in at least two directions, and
detects a relative angle with respect to a magnetic
field from said magnetic components, said apparatus
comprising:
25 control means for controlling an output signal in
a first direction component detected by said first
magnetic sensor unit so as to have a fixed value; and
driving means for driving said second magnetic
sensor unit to detect an output signal in a second
30 direction component according to the same drive
conditions as those at the time when said first
magnetic sensor unit is controlled by said control
means.
- 35 3. The angle detection apparatus according to claim 1
or 2, wherein said first magnetic sensor unit and said
second magnetic sensor unit include an opposed pair of
magnetic sensors, respectively, and said pair of
magnetic sensors are arranged on straight lines
40 perpendicular to each other.
4. The angle detection apparatus according to any one
of claims 1 to 3, wherein said first magnetic sensor
unit and said second magnetic sensor unit are arranged
45 near an end of a magnetic flux concentrator.
5. The angle detection apparatus according to any one
of claims 1 to 4, wherein said control means includes

a feedback control loop for controlling the output signal in said first direction component so as to have said fixed value.

- 5 6. The angle detection apparatus according to claim 5, wherein said control means includes feedback stop means for disconnecting said feedback control loop.
- 10 7. The angle detection apparatus according to claim 5 or 6, wherein said feedback control loop includes an operational amplifier, one of the output signal in said first direction component and the output signal in said second direction component is inputted to an inverted input terminal of the operational amplifier
15 via a resistor, and a reference input voltage is inputted to the inverted input terminal of the operational amplifier via a resistor.
- 20 8. The angle detection apparatus according to claim 7, wherein the output signal in said first direction component or the output signal of said second direction component, which is inputted to the inverted input terminal of said operational amplifier, is
25 determined on the basis of a designation supplied from a designation input unit.
- 30 9. The angle detection apparatus according to claim 7 or 8, wherein a PI regulator is connected between an output terminal and the inverted input terminal of said operational amplifier.
- 35 10. The angle detection unit according to any one of claims 6 to 9, wherein said feedback stop means drives said first and second magnetic sensor units at a
predefined constant voltage.
- 40 11. The angle detection apparatus according to any one of claims 7 to 10, wherein said feedback stop means causes said operational amplifier to operate as a voltage follower.
- 45 12. The angle detection apparatus according to any one of claims 7 to 11, wherein said first and second magnetic sensor units are driven on the basis of a voltage obtained from the output terminal of said operational amplifier.

13. The angle detection apparatus according to any one of claims 1 to 12, wherein said first and second magnetic sensor units are driven in accordance with a spinning current method.

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14. The angle detection apparatus according to any one of claims 6 to 13, further comprising:

an area judging means for, immediately after a power supply of the angle detection apparatus is inputted, performing judgment of an angle area on the basis of detection outputs from said first and second magnetic sensors for detecting magnetic components in at least two directions, while retaining a state in which a function of said feedback control loop is stopped by said feedback stop means.

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15. The angle detection apparatus according to claim 14, wherein in performing the judgment of an angle area, said area judging means uses absolute values and positive and negative of signs of the output signals in said first and second direction components obtained from said first and second magnetic sensor units.

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16. The angle detection apparatus according to any one of claims 1 to 15, further comprising:

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sign reversing means for reversing the signs of the output signals in said first and second direction components, which are detected on the basis of the outputs from said first and second magnetic sensor units, respectively, according to the relative angle with respect to the magnetic field; and

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component switching means for switching the output signal in said first direction component, which should be controlled so as to have said fixed value, to the output signal in said second direction component:

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wherein said angle detection apparatus expands a detectable range of angles.

17. The angle detection apparatus according to claim 16, wherein after switching the output signal in said first direction component to the output signal in said second direction component, said component switching means switches the output signal in said second direction component to the output signal in said first direction component again.

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18. The angle detection apparatus according to any one of claims 1 to 17, further comprising:

counting means for performing a counting operation for a predetermined clock in response to the output signal in said first direction component detected by said first magnetic sensor unit or the output signal in said second direction component detected by said second magnetic sensor unit;

first transforming means for transforming a counted value of said counting means into a predetermined transformation value;

a counting stop means for comparing a value of the output signal in said first or second direction component with said transformation value and stops the counting operation by said counting means when said transformation value has reached the value of the output signal in said first or second direction component; and

second transforming means for transforming said counted value into angle information.

19. The angle detection apparatus according to claim 18, wherein said counted value corresponds to a detection angle θ and said transformation value corresponds to $\tan \theta$.

20. The angle detection apparatus according to claim 18 or 19, wherein said first transforming means has a logic circuit for transforming the detection angle θ into $\tan \theta$.

21. The angle detection apparatus according to any one of claims 18 to 20, wherein said counting stop means is a comparator that has a first input terminal, to which a tangent value detected on the basis of an output from said first magnetic sensor or second magnetic sensor is inputted, and a second input terminal, to which a tangent value corresponding to an output from said first transforming means is inputted.

22. The angle detection apparatus according to any one of claims 18 to 21, wherein an output terminal of said first transforming means and an input terminal of said counting stop means are connected via a D/A converter.

23. The angle detection apparatus according to claim 22, wherein said angle detection apparatus uses, as a reference voltage for said D/A converter, an output signal in a direction component, which is controlled so as to have said fixed value, out of said first and

second output signals that are detected on the basis of outputs from said first and second magnetic sensor units.

- 5 24. The angle detection apparatus according to any one of claims 18 to 23, wherein said second transforming means performs predetermined interpolation processing for obtaining said angle information.
- 10 25. The angle detection apparatus according to any one of claims 18 to 24, further comprising:
offset correcting means that is inputted with the output signals in said first and second direction components, which are detected on the basis of the
15 output from said first magnetic sensor unit or said second magnetic sensor unit, and applies addition processing for an offset angle value to the angle information outputted from said second transforming means.
- 20 26. The angle detection apparatus according to any one of claims 1 to 25, further comprising:
judging means for dividing a signal depending upon an angle into plural angle areas, which change
25 linearly with respect to the angle:
wherein said angle detection apparatus performs extraction of an angle according to adjustment of an inclination of an approximate straight line and linear transformation by offset addition.
- 30 27. The angle detection apparatus according to any one of claims 1 to 26, wherein said first and second magnetic sensor units have Hall elements.
- 35 28. The angle detection apparatus according to claim 22, wherein said Hall elements are arranged near an end of a magnetic flux concentrator.
- 40 29. An angle detection system, wherein a semiconductor device having the angle detection apparatus according to any one of claims 1 to 28 formed on a semiconductor substrate is set near a rotating permanent magnet to detect a rotation angle of the permanent magnet.